

Application No. 09/589,299

Filed: June 7, 2000

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43. A computer in communication with the display device of claim 21.

44. A personal digital assistant in communication with the display device of claim 21.

REMARKS

Claims 1-7, 9-11, 28-29, and 37 have been rejected under 35 U.S.C. § 102(e) over Amafuji et al. (US Pat. No. 6,292,158). Amafuji discloses a display system incorporating an off-axis optical system. Independent claim 1 as amended recites an axial or on-axis optical system. Support for this amendment can be found in the specification at, for example, page 3, line 31, through page 4, line 13; and page 6, line 2, through page 10, line 19.

An axial or on-axis optical system refers to an optical design in which light is incident on optical surfaces having rotational symmetry about the optical axis and thus does not require correction of aberrations induced by an off-axis geometry. In an off-axis design, the resulting aberrations are visible to the average viewer unless some form of aberration correction is also employed. The concepts of axial or on-axis and non-axial or

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off-axis systems are simple to define for reflective curved surfaces, because these surfaces have a center of curvature and a vertex and in general have rotational symmetry about a line connecting the center of curvature and vertex. A system is axial if a ray from the center of the object (or the display) passes through the center of curvature of the reflective surface and also passes through the center of the pupil of the eye. See, for example, US Pat. No. 6,353,503 (col. 1, lines 47-67) (copy enclosed for Examiner's convenience).

In Fig. 1 of Amafuji, an off-axis mirror design is shown. There is no indication in Amafuji that an axial approach be used in, for example, the embodiment illustrated in Fig. 5, to which the Examiner refers. Accordingly, claim 1 and the claims dependent therefrom are believed to be patentable over Amafuji.

Claims 12-20 have been rejected over Amafuji in view of Fan et al. (US Pat. No. 5,815,126) and further in view of Handschy et al. (US Pat. No. 5,596,451). Claim 13 has been rewritten in independent form and recites that the eyepiece assembly is disposed within a hollow, transparent, spherical housing. Neither Fan nor Handschy discloses a hollow spherical housing. The spherical housing provides a safety advantage, because the housing has no sharp edges and accidental impact with the face or eye is

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not unusually threatening to health or vision. (Applicant's specification, page 8, lines 19-28.) Accordingly, claim 13 and the claims dependent therefrom are also believed to be patentable over Amafuji in view of Fan and Handschy.

Claims 21-22 and 24 have been rejected under § 103(a) over Amafuji in view of Carollo (US Pat. No. 6,144,439). Claim 21, which has been rewritten in independent form, recites that the eyepiece assembly comprises a solid optical material having an external surface and an internal reflective surface. The material has an index of refraction selected so that light from the display incident on the external surface is refracted as the light propagates into the material and is reflected off the internal reflective surface. The advantage of the presently claimed system is that aberrations are reduced by refraction, making the system more close to an axial system.

The Examiner notes that Carollo discloses a meniscus lens 220 that refracts entering light. After passing through the lens 220, the light is transmitted to a CLC that reflects it back to the lens 220. The light is then reflected from an external reflective surface of the lens 220 to the eye.

More particularly, in the present invention, light from the projection system is refracted as it enters the solid optical

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material and is then reflected from an internal reflective surface. In Carollo, light is not reflected from an internal reflective surface of the lens 220. Accordingly, claim 21 and the claims dependent therefrom are believed to be patentable over Amafuji in view of Carollo.

Claim 8 has been rejected under § 103(a) over Amafuji in view of Taniguchi et al. (US Pat. No. 6,023,253). This claim is believed to be patentable for the reasons set forth with respect to claim 1 and no further comment thereon is believed necessary at this time.

Claims 23 and 25 have been rejected under § 103(a) over Amafuji and Carollo and further in view of Takahashi (US Pat. No. 5,701,202). These claims are believed to be patentable for the reasons set forth above with respect to claim 21, and no further comment thereon is believed necessary at this time.

Claims 26-27 have been rejected under § 103(a) over Amafuji and Carollo and further in view of Fan et al. (US Pat. No. 5,815,126). These claims are believed to be patentable for the reasons set forth above with respect to claim 21, and claim 27 is further believed to be patentable for the reasons set forth above with respect to claim 13. No further comment is therefore believed necessary at this time.

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Claims 30-32 have been rejected under § 103(a) over Amafuji in view of Lebby et al. (US Pat. No. 5,469,185). These claims are believed to be patentable for the reasons set forth above with respect to claims 1, 13, and 21, and no further comment thereon is believed necessary at this time.

Claims 33-35 have been rejected under § 103(a) over Amafuji in view of Fan et al. (US Pat. No. 5,815,126). These claims are believed to be patentable for the reasons set forth above with respect to claims 1, 13, and 21, and no further comment thereon is believed necessary at this time.

Claim 36 has been rejected under § 103(a) over Amafuji in view of Newman et al. (US Pat. No. 5,844,824). This claim as well as new claims 39 and 42 are believed to be patentable for the reasons set forth above with respect to claims 1, 13, and 21, and no further comment thereon is believed necessary at this time.

Claim 38 has been rejected under § 103(a) over Amafuji in view of Horiuchi (US Pat. No. 6,304,234). This claim as well as new claims 41 and 44 are believed to be patentable for the reasons set forth above with respect to claims 1, 13, and 21, and no further comment thereon is believed necessary at this time.

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New claims 40 and 43 are similar to claim 37 and are believed to be patentable for the reasons set forth above with respect to claims 13 and 21.

Claims 10 and 16 have been amended to correct a lack of antecedent basis and a typographical error.

In view of the above amendments and remarks, Applicant submits that all claims are in condition for allowance, and reconsideration and indication thereof are respectfully requested. The Examiner is encouraged to telephone the undersigned attorney to discuss any matter that would expedite prosecution of the present application.

Respectfully submitted,

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Enclosure

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MARKED-UP VERSION OF AMENDMENTS

1. (Amended) A compact display device for transmitting an image to a user's eye, the display device comprising:

a head-mountable support fixture comprising an elongated member having a first end and a second end;

a projection system including a display operative to provide an image, the support fixture attached at the first end to the projection system; and

an eyepiece assembly attached to the second end of the support fixture, the eyepiece assembly comprising an axial optical system;

wherein the support fixture maintains the projection system and the eyepiece assembly in alignment along an optical path through free space between the projection system and the eyepiece assembly, with the projection system disposed to transmit the image on the optical path and the eyepiece assembly disposed to receive the image from the projection system and to direct the image to the user's eye.

10. (Amended) The device of claim 1, wherein the projection system further comprises a lens oriented to direct light from the display onto the ~~axial~~ optical path.

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13. (Amended) ~~The device of claim 1,~~ A compact display device for transmitting an image to a user's eye, the display device comprising:

a head-mountable support fixture comprising an elongated member having a first end and a second end;

a projection system including a display operative to provide an image, the support fixture attached at the first end to the projection system; and

an eyepiece assembly attached to the second end of the support fixture, wherein the eyepiece assembly is disposed within a hollow, transparent, curved spherical housing;

wherein the support fixture maintains the projection system and the eyepiece assembly in alignment along an optical path through free space between the projection system and the eyepiece assembly, with the projection system disposed to transmit the image on the optical path and the eyepiece assembly disposed to receive the image from the projection system and to direct the image to the user's eye.

16. (Amended) The device of claim 13, wherein the eyepiece assembly further comprises a lens having an outer surface forming



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a part of the curved housing and an inner surface, the curvatures of the outer surface and the inner surface selected to ~~provided~~ provide a desired degree of magnification or aberration correction of light on the ~~axial~~ optical path.

21. (Amended) ~~The device of claim 1,~~ A compact display device for transmitting an image to a user's eye, the display device comprising:

a head-mountable support fixture comprising an elongated member having a first end and a second end;

a projection system including a display operative to provide an image, the support fixture attached at the first end to the projection system; and

an eyepiece assembly attached to the second end of the support fixture;

wherein the support fixture maintains the projection system and the eyepiece assembly in alignment along an optical path through free space between the projection-system and the eyepiece assembly, with the projection system disposed to transmit the image on the optical path and the eyepiece assembly disposed to receive the image from the projection system and to direct the image to the user's eye; and

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wherein the eyepiece assembly comprises a solid optical material having an external surface and an internal reflective surface, the material having an index of refraction selected so that light from the projection system incident on the external surface is refracted as the light propagates into the material and is reflected off the internal reflective surface.

28. (Amended) The device of ~~claim~~ claims 1, 13, or 21, further comprising a housing, the projection system disposed within the housing, circuits and wiring in electrical communication with the projection system disposed within the housing, and the support fixture attached to the housing.